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EXHIBIT A

Species: **Brassica Crops**

- Characteristics & Adaptation
- Establishment
- Harvest Management
- Fertility
- Pests: Weeds, Insects, or Diseases

- Return to PSU Forage Home Page

Additional brassica information via the Forage Information System (FIS)

Please note: Penn State University Forages on the World Wide Web (WWW) is under construction. Work was initiated in May, 1995. Information is incomplete and linkages to local or remote sites may not work but construction is being completed as fast as possible.

This WWW page was developed by Marvin H. Hall (mhh2@psuvm.psu.edu). Last updated 5/1/95.

Characteristics & Adaptation of Brassica Crops

Cool-season perennial grass and grass-legume pastures typically become less productive as the grazing season advances from June to November. Forage brassica crops such as turnip, swede, rape, and kale can be spring-seeded to supplement the perennial cool-season pastures in August and September or summer-seeded to extend the grazing season in November and December. Brassicas are annual crops which are highly productive and digestible and can be grazed 80 to 150 days after seeding, depending on the species. In addition, crude protein levels are high, varying from 15 to 25 percent in the herbage and 8 to 15 percent in the roots depending on the level of nitrogen fertilization and weather conditions.

Adapted Brassica Species & Varieties

Kale (Brassica oleracea L.)

Varieties of kale differ markedly in rate of establishment, stem development, time required to reach maturity, and in winterhardiness. The stemless type kale (e.g. Premier) has a faster rate of establishment than varieties which produce stems. Crop height of the stemless type is approximately 25 inches,

whereas that of marrow stem kale is 60 inches with primary stems often 2 inches in diameter. Stemless kale attains maturity in approximately 90 days, allowing two crops/year, whereas varieties that develop stems require 150 to 180 days to attain maximum production (Table 1). Premier has consistently survived winters in central Pennsylvania, whereas other varieties of kale usually are winter-killed in December.

Rape (Brassica napus L.)

Mature forage rape is one of the best crops available for fattening lambs and flushing ewes. Rape is a multistemmed crop with fibrous roots. The stems vary in length, diameter, and in palatability to livestock. Forage yields of spring- planted rape increase until plants become physiologically mature. Growth slows or ceases at maturity and yields plateau until leaves senesce and die. Varieties differ in when this occurs, however, Rangi rape retains its leaves longer than most varieties. Generally, yields of rape varieties in Pennsylvania are maximized with two , 90-day growth periods (Table 1). However, performance of Emerald and Winfred rape varieties, is best with one 180-day growth period, and yields of rape hybrids were greatest with 60 days of growth before the first harvest and a 30-day growth period before the second harvest.

Swede (Brassica napus L.)

Like turnip, swedes produce a large edible root. Yields are higher than those of turnip, but they grow slower and require 150 to 180 days to reach maximum production. Swedes usually produce a short stem (neck), but can have stems 2 1/2 feet long when grown with tall crops which shade the swede. Unfortunately, stem elongation is at the expense of root development. The variety Calder was found to be cold hardy in central Pennsylvania and thus ideal for stockpiling and late fall or early winter grazing (Table 1). In general, all swede varieties are recommended for late fall grazing.

Turnip (Brassica rapa L.) or Turnip Hybrids

These crops grow very fast, reaching near maximum production levels in 80 to 90 days (Table 1). Studies in southwestern Pennsylvania showed that turnip can accumulate dry matter in October as fast as field corn does in August. Growing "out of season" (October/November) makes turnip a valuable crop for late fall grazing.

The proportions of tops and roots varies markedly depending on variety, crop age, and planting date. Research by the USDA Pasture Laboratory showed that turnip crops can vary from 90 percent tops/10 percent roots to 15 percent tops/85 percent roots. Some hybrids have fibrous roots which will not be readily grazed by livestock. All varieties produce primarily tops during the first 45 days of growth. Sixty to 90 days after seeding, turnip varieties such as Savannah and All Top continue to produce a high proportion of tops. During the same period, other turnip varieties have nearly equal top and root production and Purple Top has a greater root than top production. The significance in the proportion of tops and roots is that the crude protein concentration (8 to 10%) of roots is approximately one-half of that in turnip tops. Therefore, greater root production tends to reduce the crude protein yield of the total crop. On the other hand, stockpiled tops appear to be more vulnerable to weather and pest damage than roots. Varieties differ in resistance to diseases, but this often is not evident until the crop is more than 80 days of age and the plants are reaching full production.

Other Forage Brassicas

Several hybrids of brassica species are also used as forage crops, however, there is limited research information on the production and management of these hybrids. The more common hybrids include a

cross between Chinese cabbage (Brassica campesteris sensulato L.) and rape (Perko), turnip (Tyfon, Buko), and swede (Wairangi).

Table 1. Characteristics and seeding rate of brassica forage crops.

Crop	Plant part consumed	Seeding to harvest	Regrows after harvest	Seeding rate
		days		pounds/acre
Kale	herbage	150 to 180	no*	3.5 to 4
Rape	herbage	80 to 90	yes	3.5 to 4
Swede	herbage & root	150 to 180	no	1.5 to 2
Turnip	herbage & root	80 to 90	yes	1.5 to 2

* An exception is the stemless variety 'Premier' which is ready for harvest 80 to 90 days after seeding and will regrow after harvest if not grazed below 3 to 4 inches.

Brassica Crop Establishment

All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production. Good stands can be established by planting 3.5 to 4 pounds per acre of kale or rape, or 1.5 to 2 pounds per acre of swede or turnip. The higher seeding rates are recommended for spring plantings. The seeds should be planted in rows 6 to 8 inches apart and not more than one-half inch deep. However, brassica seed can also be broadcast and incorporated into tilled seedbeds by cultipacking. When preparing a tilled seedbed for brassica planting, plow the ground several weeks before planting to allow weed seeds to germinate before secondary tillage is completed to form a firm and fine seedbed that is free of weeds. In addition, the preplant incorporated herbicide, Treflan (Trifluralin), is labeled at 0.5 to 1.0 pint active ingredient per acre for control of annual grass and small seeded broadleaf weeds in brassicas.

Brassica stands can also be established by no-till planting in grass sod that is suppressed with paraquat or glyphosate herbicides. Read pesticide labels and precautions before using either of these herbicides. Ideally, the grass sod should be grazed through June with the grazing prior to brassica seeding being very close. Approximately two weeks before planting the herbicide should be applied to the grass sod. Another option for no-till establishment would be to apply a manure slurry to the sod, which will burn the sod back, and then no-till seed the brassicas seeds through the slurry. In addition to reduced erosion concerns with no-till planting, there are generally fewer insect problems than with conventionally seeded brassicas. The following recommendations will improve the chances of successful brassica establishment.

1. Attempt establishment only on well drained soils.

2. Do not seed deeper than one-half inch.

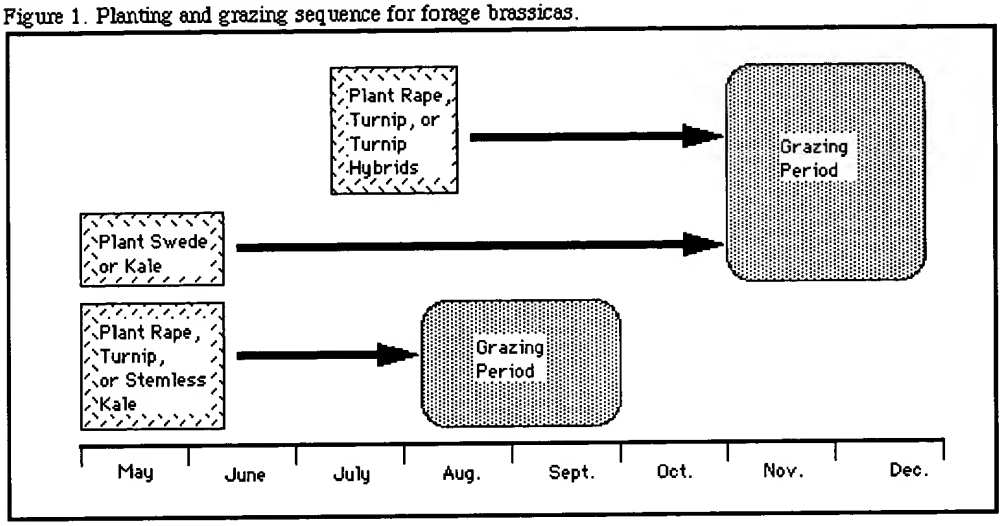
3. When seeding into a sod, suppress the sod long enough (2 to 3 weeks) to allow the brassicas to establish.

4. Apply 75 pounds of nitrogen at seeding to stimulate establishment and growth.

As previously mentioned, forage brassicas can be grown to supplement perennial cool-season pastures in August and September or to extend the grazing season in November and December. In the first instance, brassicas would be planted in May or early June when spring rains will help assure production for August and September grazing (Figure 1). Turnip, rape, or stemless kale could be used for this purpose.

In the second instance, swede or kale would be planted in spring, or rape, turnip and turnip hybrids would be planted in late July or early August, and growth allowed to accumulate until November or December.

Figure 1. Planting and grazing sequence for forage brassicas.



Brassica Harvest Management

Brassicas can be harvested for greenchop or silage but are most frequently grazed. Grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassica at a time provides the most efficient utilization. Grazing large areas increases trampling and waste of the available forage. Rape is more easily managed for multiple grazings than are the other brassica species. Approximately 6 to 10 inches of stubble should remain after grazing rape to promote rapid regrowth. Regrowth may be grazed in as few as 4 weeks after the first grazing. Graze rape close to ground level during the final grazing.

When turnips are grazed twice, only the tops should be grazed during the first grazing. Turnip regrowth is initiated at the top of the root, so this part of the plant should not be removed until the second and final grazing when the whole plant can be consumed. Like rape, regrowth of turnips can be sufficient to graze within 4 weeks of the first grazing.

Yield and Nutritional Value

Brassica dry matter yield will depend on the production potential of the soil and environment, and the brassica species. Average yields in Pennsylvania have been 3.1 tons of dry matter per acre at 90 days after planting. Slower maturing kale and swede average over 4 tons per acre at 120 days after planting. For a grazing situation, an average carrying capacity of a good brassica stand would be approximately 1550 ewe- or 160 cow-grazing days per acre.

Dry matter digestibility generally exceeds 90 percent for all plant parts except kale stems at maturity. By comparision, dairy quality alfalfa hay is approximately 70 percent digestible. With adequate fertility, brassicas can produce equivalent amounts of digestible energy per acre as corn yielding 115 bushel per acre. Unlike perennial forage crops, the dry matter digestibility of brassicas does not decrease markedly with increasing plant maturity. This characteristic makes them ideal for stockpiling. Ruminant diets

should not contain more than 75 percent brassica forage because the fiber content of brassica crops is too low for maintenance of proper rumen activity. With their high digestibility and low fiber content, brassicas should actually be considered as "concentrates" rather than "forage" in nutritional planning for livestock. Crude protein concentration of brassicas range from 8 to 10 percent in turnip roots to 30 percent in rape leaves.

Feeding Concerns

Brassica crops can cause health disorders in grazing animals if not managed properly. The main disorders are bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism, and polioencephalomalacia. Researchers have discovered that these disorders can be avoided by adhering to a couple management rules:

1. Introduce grazing animals to brassica pastures slowly. Avoid abrupt changes from dried-up summer pastures to lush brassica pastures. Don't turn hungry animals that are not adapted to brassicas into a brassica pasture.

2. Brassicas should not constitute more than 75 percent of the animal's diet. Supplement with dry hay if continually grazing brassicas or allow grazing animals access to grass pastures while grazing brassicas. No-till establishment into existing sod will reduce the risk of these disorders because of grass in the brassica pasture.

Brassica Fertilization

Phosphorus and potassium soil test levels should be in the optimum range prior to planting. If the phosphorus level is below 55 pounds per acre, the application of phosphorus during brassica development may be warranted. Application under this condition tends to increase yield if nitrogen is not limiting growth. However, phosphorus applications decrease crude protein concentration of the brassica forage.

In addition to the nitrogen applied at planting, when multiple grazings are planned an additional 70 pounds should be applied between 60 and 80 days after seeding to increase yield and crude protein level of the brassica tops. Unfortunately, the nitrogen induced yield increase in turnip and swede tops causes a reduction in root yield. When seeding into a suppressed grass sward, nitrogen application tends to increase the efficacy of the suppressing herbicide and reduces the proportion of grass in the brassica-grass sward.

Brassica Pests

Once established, brassicas are very competitive with weeds. However, precautions should be made prior to planting to reduce weed competition during brassica establishment.

Insects, such as aphids, flea beetles, and imported cabbage worms, that feed on brassicas are not consistently a problem in Pennsylvania. However, appropriate use of insecticides may be warranted if insect populations become severe.

Diseases such as bacterial soft rot of brassica roots and leaf spot are generally not a problem until the plants near maturity. Stockpiling (delaying grazing until a later date than maturity) should not be attempted in fields were brassicas have high levels of foliar disease at maturity. Research has shown yield reductions of 40 percent when disease infected brassica crops were stockpiled for 45 days. Generally, Forage Star turnip and Rangi rape are better suited for stockpiling than other varieties because of lower disease infestation. To reduce disease occurrence, brassicas should not be grown on the same field for more than two consecutive years.

Brassica Crop Summary

Brassica crops can produce high yields of highly digestible forage during periods when perennial forages have limited production. In addition, the digestibility of the forage remains high over a relatively longer period than perennial crops. Few crops offer as much potential as do brassicas to improve livestock carrying capacity from August through December. Spring-seeded brassicas can be used to supplement low producing cool-season pastures or as insurance against summer drought. Summer-seeded brassicas can extend the potential grazing season by providing forage for fall and winter grazing. These characteristics make the use of brassica crops in grazing situations very flexible and appealing to producers utilizing pastures in their livestock operation.

Prepared by Marvin H. Hall and Jerry Jung, associate and adjunct professors of agronomy, respectively.

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The Brassica napus Sequence Analysis Project is a joint effort between the University of Minnesota and the the Plant Molecular Genetics Laboratory at Pohang University of Science and Technology.

The sequence analysis tools that we have developed for the *Arabidopsis* cDNA Sequencing Project have been adapted for use with *Brassica napus* (oilseed rape) cDNA sequences. Currently, over 650 sequences have been processed with these tools.

For further information on the sequencing side, please contact

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We'd like to hear from you! If it's convenient for you, use this mailto dialog box, or send e-mail the usual way to comments@mail.ahc.umn.edu.

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Brassica and Oilseeds Research Department

Head of Department: Dr Steve Rawsthorne

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Welcome to the Brassica & Oilseeds Department on Tuesday, 24th July

Our Department was established in 1990 and has now gained an international repu
Our major research goal is the development and application of genetical and biocl
approaches to define key agronomic characters of oilseed and vegetable crops tha
allow for their sustainable improvement. We chiefly study the various *Brassica* ci
species that have a close taxonomic relationship with the model species *Arabidop
thaliana*.

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This page last updated 10/5/2000 - Martin Trick

PATENT
22851.030-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:
WENYUAN SHI AND MAXWELL H. ANDERSON

Serial No. 09/378,577

Intl. Filing Date August 20, 1999

For: METHOD FOR THE TREATMENT AND PREVENTION OF DENTAL CARIES

CERTIFICATE OF MAILING

Hon. Assistant Commissioner for Patents
Washington D.C. 20231

I hereby certify that a Petition to Extend Time, Response to Office Action and Amendment Under 37 C.F.R. § 1.111, Check number 238769 in the amount of $1,890.00 and Return Postcard are being deposited with the United States Postal Service; postage prepaid, Express Mail No. **EL 842079414US** on the date indicated below and addressed to: *Hon. Assistant Commissioner of Patents, Washington, D.C. 20231.*

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